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Parasites of the Hessian Fly in the North Central States

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Investigations to determine the value of parasites of the hessian fly (*Phytophaga destructor* (Say)) in wheat-growing areas of the North Central States were conducted from 1937 through 1950 as opportunities were afforded.

The status of hessian fly parasites in the Atlantic States has been reported by Hill *et al.* (5),³ and the taxonomy and life history of the important species have been discussed by Hill and Pinckney (4), Gahan (1), Hill and Emery (3), and Hill (2).

EXPERIMENTAL PROCEDURE

The hessian fly larvae and puparia were collected annually from wheat fields in various parts of the North Central States. A few collections were also made in Arkansas and Oklahoma.

Owing to differences in latitude and topography, the material was segregated to represent six areas: (1) Indiana and Ohio; (2) southern Michigan; (3) Illinois; (4) Missouri and northern Arkansas; (5) eastern Kansas, southeastern Nebraska, and northeastern Oklahoma; and (6) Iowa. Although it was not possible to obtain material each year over the entire territory, enough samples were collected and studied to give representative information for each area.

¹ Retired October 31, 1951.

² Most of the material studied was collected by W. B. Cartwright, Lafayette, Ind., and E. T. Jones, Manhattan, Kans., both of the Division of Cereal and Forage Insect Investigations. Helpful criticism of the manuscript was received from W. B. Cartwright of this Bureau and from F. M. Wadley, formerly with the Bureau.

³ Italic numbers in parentheses refer to Literature Cited, p. 15.

TABLE 1.—Parasitization of spring-generation hessian flies in Indiana and Ohio collected after the middle of July

Year	Number of counties	Number of host puparia	Percent of flies parasitized by—												Total percent parasitization	
			<i>Eupelmus allyni</i>	<i>Platygaster zosine</i>	<i>Merisus destructor</i>	<i>Pleurotropis metallicus</i>	<i>Eupelmella vesicularis</i>	<i>Merisus febriculatus</i>	<i>Tetrastichus carinatus</i>	<i>Platygaster herrickii</i>	<i>Eupleromachus subapterus</i>	<i>Centrodora spectosissima</i>	<i>Buryloma</i> sp.	<i>Ditropinotus aureoviridis</i>		Undetermined chalcids
1937----	6	1,181	28.7	10.7	14.8	0.2	T ¹	0.8	0	0	0.2	0	0	0	18.5	74.0
1938----	28	2,613	25.4	21.8	10.6	.8	0.3	.2	.1	0	0	0	0	0	17.1	76.3
1939----	3	3,102	31.0	19.4	7.3	.8	1.4	.5	.1	0	.1	0	0	0	15.7	76.3
1940----	6	327	28.1	.3	4.3	.3	0	.9	0	0	0	0	0	0	21.5	55.4
1941----	7	2,233	16.7	28.2	4.3	.9	.1	.3	.5	.5	.1	.1	0	0	16.0	67.7
1942----	6	1,017	32.8	16.4	8.4	2.1	.1	0	T ¹	0	0	.1	0	0	15.4	75.4
1943----	5	560	20.9	24.1	3.8	2.9	0	.2	1.1	0	.2	0	0	0	18.8	72.0
1944----	3	89	23.6	27.0	6.7	0	0	0	0	0	0	0	0	0	21.3	78.6
1945----	3	411	23.6	2.9	19.3	1.8	0	.3	0	0	0	0	0	0	23.8	71.7
1946----	6	755	21.3	22.6	13.6	2.6	1.1	0	.1	0	0	0	0	0	19.7	81.0
1947----	3	1,009	22.6	35.0	9.3	5.8	1.1	.1	.2	0	0	0	.2	.1	11.9	86.3
1948----	8	678	30.4	10.5	12.2	1.2	.1	0	1.0	0	0	.1	0	0	17.7	73.2
1949----	2	142	29.6	36.6	7.7	4.9	0	0	0	0	0	0	0	0	6.3	85.1
Average----		-----	25.7	19.7	9.4	1.9	.3	.3	.2	T ¹	T ¹	T ¹	T ¹	T ¹	17.2	74.8

¹ Trace.

The maximum parasitization of the hessian fly is usually reached during July. Consequently, the material collected earlier in the year was not used to determine total parasitization or to gage the relative importance of those parasites that normally attack the fly during the summer. The earlier collections, most of which were made during June, were useful, however, in evaluating certain Proctotrupeidea that oviposit in the eggs of the host and for distributional records of different parasites.

Determinations of the species were made by dissecting the host larvae and puparia and examining the contents microscopically. If the parasite had already emerged from its host, the species was often determined from the pupal sclerites and exuviae of the escaped parasite. A key to such remains developed by Hill and Pinckney (4) was used for this purpose.

RESULTS

At least 16 species of hymenopterous parasites attack the spring-generation hessian flies in Ohio, Indiana, Illinois, and Michigan. They are as follows:

CHALCIDOIDEA

Callitula bicolor Spinola
Centrodora speciosissima (Girault)
Ditropinotus aureoviridis Crawford
Eupelmella vesicularis (Retzius)
Eupelmus allynii French
Eupteromalus americanus Gahan
Eupteromalus subapterus (Riley)
Eurytoma (species undetermined)
Merisus destructor (Say)
Merisus febriculosus Girault
Merisus mordellistenae Crawford
Pleurotropis metallicus (Nees)
Tetrastichus carinatus Forbes

PROCTOTRUPEIDEA

Platygaster herrickii Packard
Platygaster hiemalis Forbes
Platygaster zosine Walker

INDIANA AND OHIO

In Indiana and Ohio samples of hessian fly puparia of the spring generation were collected after the middle of July from 1937 through 1949. The data are summarized in table 1.

Ditropinotus aureoviridis, which is widely distributed in wheat-growing areas, is primarily a parasite of the wheat jointworm (*Harmolita tritici* (Fitch)), but occasionally attacks the hessian fly.

Since *Platygaster zosine* oviposits in the egg of the host and suffers some mortality from encroaching chalcidoid parasites before it can mature, material collected early in the season, as summarized in table 2, shows the potential value of this parasite to best advantage.

Two other parasites of the hessian fly from this area include *Callitula bicolor* recorded from Tippecanoe County, Ind., in unpublished notes by P. M. Myers, formerly with the Bureau of Entomology and Plant Quarantine, and *Merisus mordellistenae* reported from Lafayette, Ind., by Gahan (1).

In Ohio and Indiana the fall-generation flies were parasitized principally by *Platygaster hiemalis*. The amount of parasitization by this species has fluctuated greatly. Records from Tippecanoe County show that 45.5 percent of 200 host puparia were parasitized in 1938, 5.7 percent of 400 puparia in 1941, 2.0 percent of 300 in 1945, and 47.3 percent of 300 in 1948.

Twenty-five samples of fall-generation host puparia were collected from that many counties in Indiana and western Ohio in the spring of 1939. Examination of the 4,251 hosts collected revealed parasitization by *Platygaster hiemalis* ranging from 0 to 36.3 percent per sample. The average parasitization for the entire area was 11.8 percent.

TABLE 2.—*Parasitization of spring-generation hessian flies in Indiana and Ohio collected June 2 to July 1*

Year	Number of counties	Number of host puparia	Percent of flies parasitized by <i>Platygaster</i> —		
			<i>zosine</i>	<i>herrickii</i>	<i>hiemalis</i>
1943-----	3	300	36.3	0.3	0
1946-----	35	1,779	30.0	.4	.2
1947-----	6	205	40.0	0	0
1948-----	3	397	36.0	1.8	1.8
1949-----	9	423	36.2	1.9	0
Average-----	-----	-----	35.7	.9	.4

Sometimes chalcidoids attack the fall generation to a small extent when early broods of fly puparia become lodged in volunteer wheat. A few puparia in a field in Tippecanoe County were parasitized in this way by *Eupelmella vesicularis*. Occasionally early-emerging chalcidoids attack fall-generation puparia early in the spring before the flies emerge. In 1939 two fly puparia out of 200 collected in Tippecanoe County contained pupae of *Tetrastichus carinatus*.

SOUTHERN MICHIGAN

Spring-generation host puparia were collected from several counties in southern Michigan during August and September of 1937, 1938, and 1941 and examined for parasitization. The data obtained are summarized in table 3. The total mortality due to parasites was higher than in the Indiana-Ohio area. Each of the four major parasites—*Eupelmus allynii*, *Platygaster zosine*, *Merisus destructor*, and *Pleurotropis metallicus*—also showed higher percentages.

Collections in June 1941 of 599 puparia from 6 counties and in June 1946 of 193 puparia from 4 counties in the same general area showed parasitization by *Platygaster zosine* amounting to 43.7 and 59.6 percent, respectively.

In the 1941 collection mentioned above, 7.7 percent of the puparia were also attacked by *Pleurotropis metallicus* and 7.2 percent by *Tetrastichus carinatus*, which are high for these species.

Gahan (1) has also recorded from Michigan the hessian fly parasites *Eupteromalus subapterus*, *E. americanus*, *Callitula bicolor*, and *Ditropinotus aureoviridis*. *Platygaster herrickii* had been previously recorded from this State by Hill and Emery (3) and *P. hiemalis* by Hill (2).

TABLE 3.—Parasitization of spring-generation hessian flies in southern Michigan

Year	Number of counties	Number of host puparia	Percent of flies parasitized by—						Total percent parasitization	
			<i>Eupelmus allynii</i>	<i>Platygaster zosine</i>	<i>Merisus destructor</i>	<i>Pleurotropis metallicus</i>	<i>Eupelmella vesicularis</i>	<i>Merisus febriculosus</i>		Undetermined chalcidoids
1937-----	1	200	18.0	35.5	11.5	0.5	0.5	1.0	11.5	78.5
1938-----	2	243	22.6	18.9	12.8	3.7	1.2	0	18.1	77.3
1941-----	1	193	38.3	17.6	10.4	6.8	.5	.5	13.5	87.6
Average-----		-----	26.3	24.0	11.6	3.7	.7	.5	14.4	81.1

ILLINOIS

Parasitization records for the spring-generation hessian fly were obtained from Illinois in 1919 by W. R. McConnell, formerly with the Bureau of Entomology and Plant Quarantine, and from 1937 to 1949 in the course of the investigations reported herein.

The data for 1919, presented in table 4, show the results of examination of samples collected by W. P. Flint, formerly State Entomologist of Illinois, during August and September from six counties in northern Illinois and reared and analyzed by W. R. McConnell. Chalcidoids accounted for all the parasitization shown in the table. Those most prevalent were *Eupelmus allynii* and *Merisus destructor*, with *Pleurotropis metallicus* less in evidence. Others included three specimens of *Eupelmella vesicularis* and one of *M. febriculosus* from Stephenson County, and one each of *Centrodora speciosissima* from Stephenson and Bureau Counties. According to a few isolated records, the proctotrupoid *Platygaster hiemalis* was reared from a spring-generation puparium collected in Stark County, and an adult of *Platygaster herrickii* was found in a puparium from Madison County.

TABLE 4.—*Parasitization of spring-generation hessian flies in six counties of Illinois in 1919*

County	Number of host puparia	Percent parasitized
Bureau.....	292	78.4
Grundy.....	107	65.4
Henry.....	100	76.0
LaSalle.....	315	63.8
Stephenson.....	420	73.3
Whiteside.....	110	61.8
Average.....		69.8

Table 5 summarizes the data from spring-generation material collected in various parts of Illinois, mostly during July and August, from 1937 to 1943. *Eupelmus allynii* was consistently the most common parasite, followed by *Merisus destructor*.

It is interesting to note that the average parasitization of 69.8 percent for 1919 (table 4) closely approximated that of 66.8 percent found during the years from 1937 to 1943 (table 5). The same principal species occurred in both series of observations. It is therefore probable that little change in equilibrium between the host and its parasites occurred over the 24-year period.

In order to evaluate more accurately parasitization by the Proctotrupoidea, collections of hessian fly puparia were made early in 1941, 1943, 1946, and 1949. The number of puparia ranged from 125 in 1943 to 355 in 1941. The percentage parasitized by *Platygaster zosine* ranged from 0.6 in 1946 to 27.7 in 1949; *herrickii* was recovered in 3 years out of 4, with a maximum parasitization of 12.4 percent in 1941; and *hiemalis* was found in one puparium of the spring generation in 1949. *P. zosine* was

TABLE 5.—Parasitization of spring-generation hessian flies in Illinois

Year	Number of counties	Number of host puparia	Percent of flies parasitized by—								Total percent parasitization	
			<i>Eupelmus allyni</i>	<i>Merisus destructor</i>	<i>Platygaster zosine</i>	<i>Merisus febriculosus</i>	<i>Euplteromalus subapterus</i>	<i>Platygaster herrickii</i>	<i>Tetrastichus carinatus</i>	<i>Eupelmella vesicularis</i>		Undetermined chalcids
1937	9	725	23.0	9.0	0	0	0.6	0	0	0	21.4	54.0
1938	11	619	38.3	15.2	1.0	1.3	.3	0	0	0	16.6	72.7
1939	27	1,095	32.9	15.6	11.5	.6	0	0	0	.1	20.6	81.3
1940	4	106	20.8	4.7	0	0	0	0	.9	0	36.8	63.2
1941	6	900	29.0	5.9	.2	.1	0	0	0	0	33.2	68.4
1942	4	800	25.1	13.8	0	0	.5	7.9	0	0	19.6	66.9
1943	4	210	27.6	5.2	0	0	0	0	.5	0	27.6	60.9
Average	---	---	28.1	9.9	1.8	.3	.2	1.2	.1	T ¹	25.1	66.8

¹ Trace

generally distributed over the eastern border counties from White County on the south to Kankakee County on the north, and *herrickii* over the southern part of the State as far north as Madison County on the west and Vermilion County on the east.

The fall-generation hessian flies have been parasitized by *Platygaster hiemalis* over most of Illinois. Unpublished records made by W. R. McConnell and P. M. Myers in 1917, 1918, 1919, and one by J. S. Pinckney in 1939, are summarized in table 6. Although this is by far the predominant parasite attacking the fall-generation flies in Illinois, on rare occasions a few chalcidoids have been reared in the State from the fall-generation puparia.

TABLE 6.—*Parasitization of fall-generation hessian flies by Platygaster hiemalis in Illinois*

Year	Number of counties	Number of host puparia	Percent parasitized
1917-----	9	874	32.5
1918-----	12	1,830	13.3
1919-----	9	1,326	3.0
1939-----	1	204	27.4

MISSOURI AND NORTHERN ARKANSAS

Parasitization of spring-generation hessian flies found in collections of puparia from different parts of Missouri made during the summers of 1941, 1947, 1948, and 1950 is summarized in table 7.

Collections of spring-generation host puparia were also made during June in western Missouri in 5 years to discover the amount of parasitization by the Proctotrupoidea. The results are given in table 8.

The chalcidoids *Callitula bicolor* and *Eurytoma* sp. were also recovered in western Missouri in 1946.

In northern Arkansas a survey in Carroll, Clay, Fulton, and Washington Counties made on June 10, 1943, showed a parasite complex in the spring-generation puparia similar to the one in Missouri. Out of 73 host puparia 11 were attacked by *Platygaster herrickii*. The chalcidoids *Eupelmus allynii*, *Merisus destructor*, and *Eupteromalus subapterus* were also recovered.

The examination of fall-generation fly puparia from western Missouri showed parasitization by *Platygaster hiemalis* in 5 out of the 7 years (table 9). Parasitization by this species was considerably lower than was usually found east of the Mississippi River.

EASTERN KANSAS, SOUTHEASTERN NEBRASKA, AND NORTHEASTERN OKLAHOMA

Parasitization of spring-generation hessian flies in eastern Kansas, southeastern Nebraska, and northeastern Oklahoma was determined from collections of puparia made from July to September of certain years between 1939 and 1947. The data are summarized in table 10.

TABLE 7.—Parasitization of spring-generation hessian flies collected in Missouri during the summer

Year	Area	Number of host puparia	Percent of flies parasitized by—									Total percent parasitization	
			<i>Eupelmus allyni</i>	<i>Merisus destructor</i>	<i>Platygaster herricki</i>	<i>Centrodora spectosissima</i>	<i>Ditropinotus aureoviridis</i>	<i>Eupleromalus subapterus</i>	<i>Pleurotropis metallicus</i>	<i>Eupelmella vesicularis</i>	<i>Platygaster hennalis</i>		Undetermined chalcidoids
1941	Southeast ¹	207	15.9	9.2	2.4	0	1.4	0	0	0	0	33.8	62.7
1947	West	263	23.6	21.7	1.1	0	0	0	0	0	0	26.2	72.6
1948	do	500	14.4	13.2	5.8	0	0	1.2	0	.4	.4	22.8	58.2
1950	Central ²	318	24.8	12.9	5.0	1.3	0	0	.6	0	.3	25.5	70.4
Average		---	19.7	14.3	3.6	.3	.4	.3	.2	.1	.2	27.1	66.0

¹ Mississippi, New Madrid, and Scott Counties.² Boone County.

TABLE 8.—*Parasitization of spring-generation hessian flies by Proctotrupoidea collected in Missouri during June*

Year	Area	Number of host puparia	Percent of flies parasitized by <i>Platygaster</i> —		
			<i>herrickii</i>	<i>hiemalis</i>	<i>zosine</i>
1940.....	Southwest	200	1.5	0	0
1941.....	West.....	819	7.0	.1	.1
1942.....	Southwest	220	6.8	.9	0
1943.....	West.....	539	10.9	0	0
1946.....	do.....	1,080	7.5	.5	0

Eupelmus allynii, *Merisus destructor*, and the undetermined chalcidoids were the most important parasites each year except 1946, when 19 percent of the host puparia were parasitized by *Platygaster herrickii*. *Eupleromalus subapterus* was also more common in 1946 than in any other year. This parasite has been more prevalent here than in any area that has been surveyed east of the Mississippi River. *Merisus mordellistenae* has been recorded from Trego and Sumner Counties (Gahan 1), and *Centrodora speciosissima* was recovered from hessian fly puparia collected in north-eastern Kansas early in 1943.

TABLE 9.—*Parasitization of fall-generation hessian flies by Platygaster hiemalis in western Missouri*

Year	Counties	Number of host puparia	Percent parasitized
1939.....	Greene.....	200	0
1940.....	Greene and Vernon.....	794	1.4
1941.....	Barton, Greene, and Jasper.....	710	0
1942.....	Clay, Greene, and Lawrence.....	662	4.2
1943.....	Clay, Greene, and Vernon.....	492	4.9
1945.....	Greene.....	200	2.0
1946.....	do.....	200	8.5

A collection of 200 puparia not included in the table was made on July 16, 1950, in Norton County, northwestern Kansas. This was an interesting collection because of the low total parasitization of 24 percent. The first four species listed in table 10 and *Platygaster hiemalis* occurred in this collection.

Table 11 summarizes data from host puparia collected during May and June in various years from parts of Kansas, Nebraska, and Oklahoma, and shows the extent of parasitization by *Platygaster herrickii* and *hiemalis*. The potential value of *herrickii* as a parasite in these areas under favorable conditions is shown by its comparatively heavy parasitization of 19.9 percent in 1946 in eastern Kansas and 16.4 percent in 1948 in north-

TABLE 10.—Parasitization of spring-generation hessian flies in Kansas, Nebraska, and Oklahoma

Area and year	Number of counties	Number of host puparia	Percent of flies parasitized by—										Total percent parasitization	
			<i>Eupelmus aligni</i>	<i>Merisus destructor</i>	<i>Eupleromachus subapterus</i>	<i>Platygaster herrickii</i>	<i>Merisus febriculosus</i>	<i>Eupelmella vesicularis</i>	<i>Pleurotropis metallicus</i>	<i>Eurytoma</i> sp.	<i>Ditropinotus aureoviridis</i>	Undetermined chalcidoids		
Eastern Kansas:														
1939-----	3	825	16.7	18.7	0.4	0	0.8	0.2	0	0	0	21.1	57.9	
1940-----	10	2,741	19.2	7.1	.1	0	.3	.4	0	0	0	15.4	42.5	
1941-----	29	5,060	26.3	7.6	.4	.1	.1	0	0	0	0	23.0	57.5	
1942-----	5	990	28.8	12.8	1.0	.8	.1	0	0	0	0	25.5	69.0	
1944-----	9	1,222	46.1	12.7	.1	0	0	0	.2	.1	.1	22.1	81.4	
1946-----	3	800	4.3	1.8	7.6	19.0	0	0	0	0	0	16.5	49.2	
1947-----	1	200	6.0	8.0	1.5	2.5	0	0	0	0	0	27.0	45.0	
Average-----			21.1	9.8	1.6	3.2	.2	.1	T ¹	T ¹	T ¹	21.5	57.5	
Southeastern Nebraska:														
1940-----	2	616	33.4	20.0	0	0	.5	.2	0	0	0	20.9	75.0	
1941-----	5	560	23.4	12.9	.2	0	0	0	0	0	0	18.9	55.4	
Average-----			28.4	16.5	.1	0	.2	.1	0	0	0	19.9	65.2	
Northeastern Oklahoma 1941-----	3	391	39.6	6.9	.3	0	0	0	0	0	0	36.1	82.9	

¹ Trace.

eastern Oklahoma. The other proctotrupoid, *hiemalis*, attacked the spring generation lightly but rather consistently.

TABLE 11.—*Parasitization of spring-generation hessian flies by Proctotru-
poidea in Kansas, Nebraska, and Oklahoma*

Area and year	Number of counties	Number of host puparia	Percent parasitized by <i>Platygaster</i> —	
			<i>herrickii</i>	<i>hiemalis</i>
Eastern and central Kansas:				
1943-----	38	885	4.9	0.6
1947-----		321	0	.9
Eastern Kansas 1946-----	37	2,126	19.9	.7
Southeastern Nebraska 1943-----	5	100	1.0	3.0
Northeastern Oklahoma:				
1943-----	11	308	.6	0
1946-----	15	693	7.2	.1
1947-----	13	263	0	0
1948-----		67	16.4	0

Only *Platygaster hiemalis* was found to parasitize the fall generation in eastern Kansas and southeastern Nebraska, as shown in table 12. Examination of 250 fall-generation host puparia collected from Kay and Ottawa Counties in northeastern Oklahoma on February 10, 1942, did not show any parasitization in these locations. This does not necessarily mean that *hiemalis* may not attack this host in these localities in favorable years, but does indicate its scarcity.

TABLE 12.—*Parasitization of fall-generation hessian flies by Platygaster
hiemalis in Kansas, Nebraska, and Oklahoma*

Area and year	Number of counties	Number of host puparia	Percent parasitized
Eastern Kansas:			
1939-----	3	334	0
1940-----	33	3,915	.5
1941-----	28	5,200	.6
1942-----	19	3,144	1.7
1943-----	17	2,826	18.0
1945-----	6	1,192	2.1
1946-----	4	860	11.7
Southeastern Nebraska:			
1940-----	6	529	.4
1941-----	12	2,266	1.5
Northeastern Oklahoma 1942-----	2	250	0

IOWA

Samples of hessian fly puparia were collected from Iowa between June 18 and 26, 1948. The data obtained are summarized in table 13.

TABLE 13.—Parasitization of spring-generation hessian flies in Iowa collected June 1918

Area	Number of host puparia	Percent of flies parasitized by—									
		<i>Platygaster zosine</i>	<i>Platygaster herickii</i>	<i>Platygaster hernalis</i>	<i>Bupelmus allyni</i>	<i>Merisus destructor</i>	<i>Pleurotropis metallicus</i>	<i>Bupleromalus subapterus</i>	<i>Bupelmella vesicularis</i>	<i>Centrodora spectosissima</i>	Undetermined chalcidoids
Southeastern ¹ -----	320	22.2	0	0	4.1	7.5	1.9	0	0.3	0	12.8
South central ² -----	265	7.2	.4	0	3.0	4.9	.8	0	0	0	3.4
Southern ³ -----	305	3.5	1.5	1.3	3.1	11.5	.2	0	.2	.2	11.4
West central ⁴ -----	95	0	5.3	0	2.1	14.7	0	1.1	0	0	6.3

¹ Henry, Louisa, and Muscatine Counties.

² Jasper and Polk Counties.

³ Davis, Decatur, Keokuk, Marion, Taylor, Van Buren, Wapello, and Warren Counties.

⁴ Monona, Plymouth, and Woodbury Counties.

It is interesting to note that *Platygaster zosine* was recovered in appreciable numbers from southeastern and south-central Iowa. This parasite was formerly found only east of the Mississippi with the exception of two records from extreme eastern Missouri. Light infestations of *P. herrickii* were found in south-central, southern, and west-central Iowa, and this parasite very likely occurs throughout the State. A 36-percent parasitization was reported by Hill and Emery (3) for this species in southwestern Iowa during 1931 and 1932. The low percentage of *Eupelmus allynii* and other chalcidoids may be due to collecting the host material early in the season and not allowing sufficient time for later parasitization by these insects. It will be noted that in the southern area one host was found parasitized by the less common chalcidoid *Centrodora speciosissima*. The distribution of *P. hiemalis* is probably more general over Iowa than these studies indicate, since observations were limited to fly puparia of the spring generation. The less important parasites *Merisus febriculosus* and *Eupteromalus americanus* have been recorded from this State by Gahan (1).

SUMMARY

Sixteen species of Hymenoptera are known to parasitize the spring generation of the hessian fly (*Phytophaga destructor* (Say)) in the North Central States. The amount of such parasitization, as determined by an examination of the host puparia, is summarized in table 14.

TABLE 14.—*Summary of parasitization of spring-generation hessian flies in the North Central States and Oklahoma*

Area	Years of observation	Percent of flies parasitized	
		Range	Average
Indiana and Ohio.....	13	55.4-86.3	74.8
Southern Michigan.....	3	77.3-87.6	81.1
Illinois.....	7	54.0-81.3	66.8
Missouri.....	4	58.2-72.6	66.0
Eastern Kansas.....	7	42.5-81.4	57.5
Southeastern Nebraska.....	2	55.4-75.0	65.2
Northeastern Oklahoma.....	1	82.9	82.9

In Indiana, Ohio, and southern Michigan the two parasites of greatest importance were *Eupelmus allynii* and *Platygaster zosine*, with *Merisus destructor* ranking third and *Pleurotropis metallicus* fourth. The remaining parasites in those States were of importance only in the aggregate. In southern Michigan parasitization by *P. zosine* was higher than elsewhere.

In Illinois the most valuable parasites in order of importance were *Eupelmus allynii*, *Merisus destructor*, and *Platygaster zosine*. The average parasitization of the spring generation of 69.8 percent in 1919 and 66.8 for the period 1937 to 1943 indicates that the general equilibrium be-

tween the host and its parasites had probably changed little in the 24 years.

In Missouri, northern Arkansas, eastern Kansas, southeastern Nebraska, and northeastern Oklahoma *Eupelmus allynii* ranked first in value with *Merisus destructor* second. Among the less important parasites in these States *Eupteromalus subapterus* and *Platygaster herrickii* were both widely distributed and considerably in evidence. West of the Mississippi River *P. zosine* was found plentiful in Iowa and to a slight extent in Missouri, but not elsewhere.

Hessian fly puparia of the fall generation were parasitized principally by *Platygaster hiemalis* over most of the areas studied. Chalcidoids occasionally attacked fall-generation puparia in volunteer wheat early in the fall and also early in the spring just before the flies emerged. The amount of parasitization by *hiemalis* fluctuated greatly. Records in Indiana representing 4 years showed from 2- to 47.3-percent parasitization. In Missouri there was no parasitization in 2 out of 7 years and the maximum was 8.5 percent. Data from Kansas showed no parasitization 1 year out of 7, although in 1943 it reached 18 percent. Records on 2 successive years from southeastern Nebraska showed 0.4 and 1.5 percent, and observations made in northeastern Oklahoma in 1942 showed no parasitization of the fall generation.

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